FISHERIES EVOLUTION: AQUACULTURE AS A MEANS TO SUPPORT DISPLACED HARVESTERS AND REJUVENATE RURAL ECONOMIES IN NEWFOUNDLAND AND LABRADOR

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Fisheries Evolution: Aquaculture as a Means to Support Displaced Harvesters and Rejuvenate Rural Economies in Newfoundland and Labrador

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Abstract

The fishing industry has always played an important role in the socioeconomic stability of Newfoundland and Labrador. This is not surprising when one takes into account the biological, sociological, and economic constraints placed on early settlers. However, as a result, current demographic changes are significantly affected by changes in the capture fishery and outport communities throughout this province are seeing increased levels of outmigration and even the loss of their local work force. This paper examined how the aquaculture industry is affecting the socioeconomic climate in two locations in Newfoundland and Labrador (the Green Bay and the Coast of Bays areas) in an attempt to determine how effective it may be in helping reduce outmigration and rejuvenating outport communities. A questionnaire was developed and community leaders and individuals involved in the aquaculture industry were interviewed. It was felt that the aquaculture industry, in the areas studied, was providing a significant source of employment and was helping revitalize local communities. In conclusion, it is believed that while the aquaculture industry will not be able to reduce outmigration in all outport communities, it is a viable option for several communities in addition to the fishery.

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1.0 Introduction

The fishing industry in Newfoundland and Labrador has always played an important part in the economy and culture of those who reside in this small region of the Northwest Atlantic. It was the fisheries that first convinced individuals the world around to settle in some of the most rugged coastlines imaginable. Many would agree that it was because of the Atlantic cod, and the brave individuals who followed their instincts, that the province of Newfoundland and Labrador grew to the size it is today. Furthermore, there is little doubt that the numbers of people in Newfoundland increased and decreased in direct relationship with the yearly success of the cod industry over the last few centuries.

In recent years, the province has seen a new wave of outmigration in many rural areas: many individuals are leaving the fisheries to work in other industries, often in other provinces. Many feel that because this province was settled and developed from the fisheries, this problem can only be addressed through the fisheries (FFAW/CAW 2009). However, in other communities around the world with similar economic dependence on their local fisheries, fish farms or aquaculture sites have developed which in turn have rejuvenated the local population in many instances (Ahmed and Hasan 2007, Fisheries and Oceans 2010).

This paper will examine the link between the present (and past) capture fishery and human migration trends in Newfoundland and Labrador. This is critical in demonstrating that the issue of coastal community migration and depopulation should be examined as a

fisheries issue and will most effectively be addressed within the fishing industry. In addition, this paper will examine the aquaculture industry in this province and discuss how effective it is, or can be, in stabilizing outmigration from rural Newfoundland and Labrador.

2.0 History of the Newfoundland Fishing Industry

The province of Newfoundland and Labrador has a long and dynamic history where, for the most part, the changing economic climate was the driving force for socioeconomic change and reinvention. This is especially true when examining the impact the fishing industry had on the people that live here. Newfoundland was settled primarily for the fishing industry, which today remains the economic driver in many of its coastal communities. Starting with those who first settled and made a livelihood from the fishery (Sider 2003), this industry fostered the growth of many coastal, "outport" communities (Hamilton & Butler 2001, Kennedy 1997). Furthermore, for the most part the fishing industry was, and remains the primary economic contributor in these regions. As such, when the fishery was prosperous, the outport communities in Newfoundland and Labrador prospered. However, with poor fishing seasons came great suffering to these same communities. To examine why this is the case and to provide possible solutions to this issue, it is important to first discuss the mechanisms behind the settling of Newfoundland and Labrador to find clues that explain why this region has had so many problems developing beyond the fishing industry.

2.1 The settlement of Newfoundland

It is not unexpected that the initial settling of Newfoundland and Labrador starting, on a seasonal basis in the early 1500s, was done with little concern to future regional development when permanent settlement was not legal until 1824. Rather, settlers were more concerned with getting access to the fish stock and, as a result, settled in locations adjacent to areas of rich fishing grounds (Higgins 2008a, Higgins 2008b, Sider 2003). It was not in the interest of merchants, nor Europe, to settle and develop Newfoundland and Labrador. Those involved in the early fishing industry were only concerned with access to cod fish, along with the insurance that the seasonal catch was salted and delivered back to the homeland. Sider (2003) identified two reasons for this. First, it was believed that during the winter, settlers would interfere with the seasonal migration of inshore harvesters, by means of taking the best land for farming, and depleting fuel (lumber) stocks when building homes. It was also feared that these settlers would cut ties with Britain and would sell their cod to New England vessel captains or that the harvesters themselves would bring their product to the Caribbean. Second, Britain did not want to deplete its population of trained sailors who could have been forced into the navy. It was in the best interest of Britain that fishers sail to Newfoundland and Labrador, intensively fish for the summer months, and return in the fall thus insuring a supply of cod fish for Britain while also retaining a supply of sailors for the navy.

Over the years, it became more and more beneficial for harvesters to settle and set up local fishing towns to protect their access to the cod fishing grounds. During this time,

new social relationships developed and community identity, dynamics, and culture began to form. Along with harvesters and their families, merchants performed an important role. According to Marx (D'Amato 2006, Sowell 1985) there exists a struggle between individuals of greater and lesser social power. Those who have more power push down those below them so that greater profits can be obtained. Marx referred to those in power (the elite) as the bourgeois. He identified another class that was the subordinate to the bourgeois. The proletarians referred to the individuals who worked in menial manufacturing positions and were under the influence of those that were above them in the social structure. In this case, the proletarians were the cod harvesters and their families. Using the truck system (which was the trade of produced items, in the case of Newfoundland this was salt fish) it was the fisheries merchants who fulfilled the role of the bourgeois. In Newfoundland and Labrador at this time, the harvesters claimed the right and ownership over the supply and production of salt cod. Using the truck system whereby prices and quality of produce was assigned by the merchants, a steady supply of cod fish could be insured by keeping harvesters in perpetual debt (Sider 2003).

Under a purely capitalistic system, there is a process towards equalization between supply and demand. Adam Smith (Otteson 2004, Smith 2006) defined the force that led to the equalization between supply and demand as the invisible hand and theorized that this was a natural process that would lead to equitable, market driven prices for all commodities (e.g., salt cod, labour). The interesting thing about this theory is that any outside force can offset this balancing act resulting in inequality in the market. In this case, it is possible that commodities would not obtain their full market potential. This was

the case in the Newfoundland and Labrador merchant capital system.

With the truck system, merchants had complete control over both the supply and price of salt cod. As a result, they were able to keep fishers trapped in a never ending cycle of debt. Sider (2003) outlined four features of merchant capital, and through these, we are able to understand why the merchants had such great control over the fishers, not only an economic sense, but also with respect to how communities grew and functioned. The four features he noted are:

1. The purchase of commodities from communities that generate these products through forms of work organization that they themselves control and supervise.

2. Domination at the point of exchange, not in production. The producing communities may have their own forms of domination within production; indeed, merchant capital often encourages the emergence of traditional leaders in this context, but this is a different issue.

3. Community control over the reproduction of the local preconditions for production, including, for example, the reassembly of work crews year and year, the replacement of productive tools, and the reallocation of clan lands or family hunting territories. Much of this control, which of course is not complete, pertains to the social entailments of maturation, marriage, death, and inheritance and perhaps also shapes the kinds of products that will be produced, the intensity of the work effort, and so forth.

4. Incorporation of producing communities into larger social systems in a manner that, while bringing the community within a larger and dominant social system, simultaneously emphasizes the social, cultural, and economic divergence of these communities from the centers of power and domination-either divergence within a single sociocultural system, as with peasants, or a more totalizing divergence, as with tribal people. (Sider 2003, pp. 98-99).

When this statement is taken in isolation, it is unclear what power these features bestowed to merchants. However, because of the merchants' ability to control the market for salt fish, they were able to keep outport communities in a limbo state between a tribal society and one in which the invisible hand (i.e., capitalism) would be an economic machine for the development and direction of the community. The merchant, to combat this, would only trade enough provisions to insure that the fishery would continue the next year. Because of this, it was not in the best interest of merchants to let the communities, where they held a monopoly on the trade of food and provisions, to become close to a neighboring community. In this case, it would have been possible for fishers to place the merchants in both communities in competition to achieve a better market price for their catch, therefore introducing capitalism into their social system. As well, merchants did not want communities to grow too large because the excess of salt fish would be more then they could handle. In this case, the need for the fishers to find alternate sources to sell their salt fish would increase and again would introduce Marx's class conflict, ultimately reaching resolution in the form of a capitalistic market exchange. It is for these reasons, in combination with the need to be close to areas with large cod stocks, that Newfoundland and Labrador developed an abundance of small, isolated outport communities that are unsuited to withstand the changes in the global market and fisheries.

2.2 Hegemony in the turn for resettlement

Between the 1950's and 1970's, a movement swept across Newfoundland and Labrador

that resulted in the mass resettlement of some 307 outport communities in which inhabited 28,000 people (Baker 1994, Maritime History Archive 2005).

What may have been called a massive resettlement initiative actually occurred in two stages. Although the result and rationale of each was the same, the means of how people were influenced to move were quite different. In the years prior to and after confederation, the global market for salt-dried cod shifted to one which placed higher market demands on fresh frozen cod (Wright 2001) as a result of availability of home refrigeration units. This change in market pressure created a reduction in salt fish production from 45,000 tonnes to 10,000 tonnes, while the production of fresh cod increased from 30,000 tonnes in 1956 to 150,000 tonnes in the late 1970's (Baker 1994). Resettlement between 1954 and 1975 occurred for two reasons. First, resettlement insured that all the province's residents had reasonable access to government services (schools, churches, hospitals, etc), and to household commodities such as telephones and electricity. Second, resettlement would help modernize the fishing industry through the use of trawl equipment, freezer plants, and more automated technologies (Maritime History Archive Memorial University 2005) while encouraging industries to institute growth centres where there would be an ample labour force.

During 1954 to 1965, hegemony was used by the provincial government's Department of Welfare in an attempt to meet these two goals. In 1954, only 50.4% of households in the province had electricity. This became a major point for pushing resettlement. Premier Smallwood, stated in 1957 that "people are up in arms demanding hydroelectric

development" (as cited in Baker 1994, line 142), and the only way that this would change (or the only way the provincial government was willing to deal with the problem), was through resettlement. During the first resettlement phase, hydroelectric development was used to push for resettlement by the provincial government and 110 communities were abandoned. Individuals who moved were first given all the money they needed to relocate, but later each family was paid to move with a minimum payment which started at $150. This was later increased to $600, with the clause that in order for the money to be paid all members in the community had to agree to move. This last condition is the embodiment of hegemonic force. Individuals who resisted resettlement would have felt the disapproval of those who wanted to move to another community.

In 1965, the second phase of resettlement occurred. The provincial government worked with the federal Department of Fisheries and then later with the Department of Regional Economic Expansion and the provincial Department of Community and Social Development to try and increase resettlement. Communities no longer had to have 100% community support in order to obtain the now increased government grants ($1,000 per household, an additional $200 for each individual living in the house, and up to $3,000 for additional building costs) as the community now only had to have 90% (later reduced to 80%) of the population willing to move. During this phase of resettlement, (1965-1975) 48 communities were abandoned with the relocation of 20,000 people. From 1946 to 1975, it is estimated that 307 communities were abandoned and 28,000 individuals relocated. The success of the relocation initiative has been questioned both in the past and today as problems emerged in the relocation program including: lack of jobs in the

growth centres, industrial development not occurring as planned, and that some of those individuals who moved felt that they had been forced from their hometowns, by the government, and their townsmen. Moreover, the government revealed that services such as road clearing, schooling, and mail services, would be cut if the population dropped below a certain number. This meant that the 10-20% of the population who did not agree with resettlement could possibly be left with no government services or funding to aid in a future relocation. With such problems, the government decided to stop its involvement in the resettlement program in 1970.

Although the period of resettlement will be forever marked in the minds and hearts of individuals in Newfoundland and Labrador, it would seem that hegemony played a major part in the movement and corrosiveness of the dominant group (the federal and provincial governments) to influence and force the subordinate group (outport communities) to come to a decision that they felt would be best for the future (and for the provincial and federal governments). With documents such as the Walsh report, which recommended that the provincial government provide government loans to private companies to industrialize and modernize the fishing industry and suggesting the fishery of the future should become smaller and more technically advanced, it is not surprising that resettlement became a reality (Wright 2001). Maritime History Archive, Memorial University (2005) indicated that "studies have shown that most - but by no means all - resettled families were satisfied with the move, citing such factors as better educational opportunities" (line 43). In this we see how individuals can be influenced by the dominant class to relocate from what was their home for generations with the hope of

providing a better tomorrow for their children and their children's children.

The period between 1954 and 1975 was a time of critical change for both the economic and social appearance of Newfoundland and Labrador as communities, and the fishery that existed in them for hundreds of years, were abandoned. During this period, we saw how the province manipulated fishers and their families to move toward modernization and industrialization by leaving their culture behind. When looking back, it is important to remember that these people were forced to move to growth centres for many reasons. The first was to increase their quality of life through better education and access to government facilities. However, the most important reason why resettlement occurred was due to economics. It is believed that resettlement occurred in a process to free up the cod fishery from its social tethering in order to produce a fishery that is far more efficient and one that will be able to produce higher levels of economic rent. This concept of economic rent was an important driving force to resettlement and it can be argued that it will be an important factor in the present and future fishing industry.

2.3 Between then and now

Nineteen seventy seven was a very important year in the history of Newfoundland and Labrador as it signified a major change in the climate of the world fisheries. In these years, several countries, including Canada, extended their governmental jurisdiction and fisheries management to include 200 miles of ocean water, which was then considered open water, from its base line. This meant that foreign vessels who were once allowed to

fish within this water would be forced outside this 200 mile limit (UNCLOS 2010). This was recognized by Newfoundland and Labradoreans, who left the province to seek employment on the mainland of Canada. This awareness led to a wave of moving back to the province to fish in what was seen to be a newly regained fishery (Schrank 1997). For a short time, it seemed as though efforts to decrease the province's dependence on the fishery, a dependence that was decreased through the resettlement program, once again re-emerged. According to Schrank (1997), the cod fishing industry increased by around 250% during this time. However, by around 1990, it became clear that the once abundant cod stocks had become depleted and the cod fishery was in imminent danger of collapse. The true reason of this is still unclear, although it is safe to say that the cod became depleted due to a combination of factors including overfishing, environmental factors, and poor stock size modeling. Nonetheless, on July 2, 1992, the cod fishery was placed under a moratorium resulting in the loss of over 28,000 jobs in rural Newfoundland and Labrador.

In 1992, a moratorium was called on the Atlantic cod fishery sending thousands of harvesters, processors, and fisheries related employees (boat builders, ice makers, etc) out of work. The socioeconomic impact was great for the province as a whole but this what magnified in areas where the fishing industry was the main employer. In an article by Hamilton et al. (2004), the effect of the Atlantic cod moratoria on the province and outport Newfoundland, in particular the great Northern Peninsula was discussed. Particular emphasis was placed on the importance of the fishing industry on the social and economic wellbeing of outport communities. Figure 1 illustrates the relationship

Hamilton et al. (2004) discussed between the province, outport Newfoundland and Labrador, and the fishing industry (in this case the Northern cod fishery). This is further illustrated by Hamilton and Butler (2001) in other fisheries dependent regions including the Northern Peninsula, the South Coast, Notre Dame Bay, and the Burin Peninsula (Figure 2).

From these figures, two important points can be derived. The first is that the fishing industry plays a very important with respect to population levels of Newfoundland and Labrador as a whole. This can be seen with the drastic decline in the population levels preceding the 1992 moratorium. In addition to this however, it is the outport communities that are more affected by changing economic conditions in the fishing industry. This is illustrated in Figure 1 by the significant outmigration that was seen after the moratorium in the Northern Peninsula and in the province as a whole.

After the collapse of the Northern cod fishery, the fishing industry was reinvented. This arguably begun with The Atlantic Groundfish Strategy (TAGS), which was established as an attempt to provide income support for individuals displaced by the moratorium and to create industry development (Department of Finance n.d.). This program, although ultimately seen as a failure, did eliminate many none-core fish harvesters through license buyback/early retirement strategies (Fisheries and Oceans 2002). At the end of the program, the only individuals who retained groundfish licenses were those that were committed to, or economically trapped in the fishing industry.

With the collapse of the cod fishery, there came an emergence of a new industry that would turn out to be more lucrative than the cod fishery could ever have been. What started out as a nuisance fishery, the snow crab fishery grew to 4,411 licenses issued yearly, 3,411 of those going to harvesters in Newfoundland and Labrador (FRCC 2005). Although employment levels would never reach those generated by the salt cod fishery, the snow crab fishery would become a major provider of economic stability for the province.

The switch from a cod based industry to a crustacean (Northern shrimp and snow crab) came swiftly and some individuals were able to reap great profits, which ultimately aided the province as a whole. In 2006, the fishing industry employed 26,000 individuals and generated $900 million in total provincial production value (DFA 2006a). This increased to a total landed value of $478.7 million, $1 billion in production value in 2007 (DFA 2007).

At present, as indicated by the demographic shifts shown in rural Newfoundland and Labrador, the province is on the verge of going through a modern self-motivated relocation initiative. Some speculate that this shift is the result of a displacement of human capital (Sjaastad 1962) and educated individuals are now migrating to achieve greater gains associated with higher levels of education. More educated individuals are more willing to reject their hometown for life in areas where higher levels of education reflect higher levels of pay and standards of living. Brain drain is effectively removing individuals from outports who are able to live better somewhere else, leaving those

individuals who are unable to better their situation. However, it is reasonable to speculate that this movement will be backed not only by the "brain drain" principal (Sjaastad 1962), but will also be fueled by pressures placed on fisheries management by retiring harvesters who will wish for the optimal return from their life investments when they retire.

In 2009, the Professional Fish Harvesters Certification Board (PFHCB 2009) indicated that the average age of a fish harvester was 55, so within 5 to 10 years one can expect that these people will be entering the age of retirement. These individuals who worked their full lives in the fishing industry will wish to "retire out of the industry with some dignity" (FFAW/CAW 2004). However, present methods of fisheries rationalization through combining and the buddying up system limit the opportunity for harvesters to obtain the full economic gains from their life investment. To this end, it is predicted that it is those in the fishing industry that will push for a management system where they will be able to obtain the ultimate financial gains for selling of their licenses. It will be harvesters that have ultimately pushed for an Individual Transferable Quota (ITQ) management system.

In the past, the fisheries in Newfoundland and Labrador were more or less an open access system. This meant that there was no real guidelines (such as quota setting, or licenses) of admission into the fishery; all one needed was a boat and fishing gear. Like today, fishers usually obtained what they needed to fish from their fathers. This patrilineal flow of ownership helped shape the culture and society of the province.

Over time, quotas were introduced into the fishery and individuals were granted a license to harvest and catch fish. In present years, the snow crab fishery has also been subject to a license and quota regime. This was done to provide the industry (in particular, the fishers) with something that could be used as collateral when negotiating bank loans. Furthermore, one can speculate that the introduction of licenses and quotas could be the start of a shift toward an ITQ system of management (Emery 1993).

In a fully flexible ITQ system, anyone is eligible to buy quotas. However, in a less then fully flexible ITQ system, there could be any number of constraints on who could buy and how many quotas any one person could own. In an ITQ system, individuals own the right to a certain proportion of the allocated quota every year and are free to fish their allotment, or if they so wish, to sell or rent their quota (Gylfason & Weitzman 2002). Through this process it is believed that the problem of overexploitation will be eliminated (Emery 1993). Also, ITQ systems are notorious for rationalizing the fishery to which they are implemented. Overcapacity, under an ITQ system will be reduced due to the selling and purchasing of quotas of individuals who no longer want to be in the fishery. This reduction in capacity will reduce the number of individuals in the fishery while, at the same time, create a situation where economic rent can be maximized.

In the past, licenses, boats and equipment were passed down patrilinealy from father to son. In an ITQ system, individuals who are willing to sell their license will want to obtain the maximum market price for them. It is unreasonable to believe that the son of a license holder will be able to compete economically with other potential buyers, especially if

those interested are themselves large industry corporations such as the Barry Group. In addition, once quotas are sold, it is unclear how new harvesters will be able to enter a fishery that is dominated by a handful of large corporations. Even if an individual who could not buy their father's license and quota wanted to get into the fishery after the fact, there are no guidelines that would allow that person to enter. In an ITQ system, the social and cultural structure that has existed in Newfoundland and Labrador for decades will be broken. Relocation will increase and in the end, community abandonment may be inevitable.

There is little doubt that the present fisheries are more economically feasible and productive than fisheries of past, however, this may have come at a price. As the fishing industry becomes more rationalized as harvesters leave the industry, there will be more money for fewer people. In the long run, rationalization, either through an ITQ style system or through self-rationalization (i.e., voluntary departure from the fishery), is inevitable and as the individuals that can not make a reasonable living from the industry become displaced (noting that some individuals are able to obtain a good living), so will they relocate from the outports around Newfoundland and Labrador in search for better, higher paying employment. This is supported by statistics published by Statistics Canada (Table 1 and Table 2) which illustrates not only the net migration of Newfoundland and Labradoreans from 1991 to 2006 but also the ages that made up this migration from 1996 to 2001. Presently, as Table 1 indicates, thousands of individuals are moving from this province to work away from home. Some speculate that this shift is the result of a displacement of human capital (Sjaastad 1962), as discussed earlier, and it will challenge

the economic stability of outport communities through Newfoundland and Labrador unless something is done to rejuvenate the seasonal fisheries found in outports around the province. Realizing the future implementations of outmigration from the industry, a Memorandum of Understand (MOU) steering committee was created which published a report in 2011 which suggested reducing the fishing industry through a government buy outs and a loan guarantee program. This was put forward in an attempt to control the now self rationalization within the industry due to the reduction of the work force from a lack of new employees entering the industry and the retirement of aging workers (MOU 2011). While this would help restructure the fishing industry and reduce capacity, it would do little to sustain the economic viability of many communities that now rely on the fishing industry. It may be possible however to rejuvenate outport economies and eliminate the displacement of harvesters by increasing interest and development in the aquaculture industry. Not only would this create employment for those displaced from the fishing industry, but it could also provide the opportunity for harvesters to supplement their fishing income by working in the aquaculture industry.

In many areas around the world, aquaculture has been used as a means to reduce economic uncertainty and rejuvenate local economies which relied, like outport Newfoundland and Labrador, on the fishing industry (Ahmed & Hasan 2007). In Bangladesh, the development of freshwater nurseries has provided greater levels of income resulting in increased expenditures in educational, health, shelter and is playing a significant role in the stability of rural life.

It is believed by some (FFAW/CAW 2009) that the issues now faced by the province can only be addressed within the fishery. It is believed that this province was settled and developed, as seen above, solely from the fishing industry and that it is only through the capture fisheries that these issues can be resolved. Although, this may be partly true, the aquaculture industry has been the source of significant economic growth in recent years and has provided employment for thousands of individuals both directly and indirectly. It is the purpose of this paper to examine the aquaculture industry in Newfoundland and Labrador and from this, assess its ability to act as an economic stimulus to outport communities. However, to put the aquaculture industry in Newfoundland and Labrador in perspective on the global stage, it is necessary to first examine the aquaculture industry around the world. This will include a brief discussion on the history of the aquaculture industry, methods of and reasons for developing aquaculture farms, and finish with a discussion of potential species that are and could be raised in Newfoundland and Labrador.

3.0: The Global Aquaculture Industry

When discussing the industry of aquaculture, one must examine all aspects related to and involved in the industry. First, it is common to denote aquaculture as a sub sector under fisheries. On the contrary, where the end product can be the same, the process of obtaining that final product can and is very different with respect to development and management. For example, the process of developing the end product may require the use of one or several aquaculture systems including the pond (inland or coastal) farms, cage

farms, tank/raceway farms, pens/natural enclosures, or recirculation systems (Parker 2002, Pillay & Kutty 2005, Swann 1992). In addition, like with the capture fisheries, the products from aquaculture are, for the most part, intended for human consumption and feed with greater than 90% of its products ending up on kitchen table. However, unlike capture fisheries, the remaining percentage caters to a number of market sectors including the bait industry, aquaria / ornamental / feeder fish, fee fishing, pond / lake stocking, and biological supply housing (Parker 2002, Swann 1992). Pillay and Kutty (2005) provided a list of situations where aquaculture can play a significant role to illustrate that like many natural resource based industries, the goal or outcome of aquaculture is greatly dependent on the goals and needs/wants of the sponsoring country and is highly dependent on the socio-economic circumstances and the environmental integrity. The list is as follows:

1. Increasing food production, especially of animal proteins, and achieving self-sufficiency in aquatic product supplies.

2. Producing food near consuming centres in rural areas. Thus contributing to improvement in human nutrition.

3. Supplementing or replacing capture fishery production of over-exploited fish and shellfish stocks.

4. Generating new sources of employment in rural areas, including part-time employment of farmers and small-scale fishermen, and arresting the migration of people from rural to urban areas.

5. Overall development of rural areas through integrated projects, including aquaculture.

6. Earning foreign exchange through export or saving foreign exchange through import substitution.

7. Using waste lands productively and using organic wastes for food production and environmental management.

8. Creating and maintaining leisure-time activities, including sport fishing and home and public aquaria.

9. Promoting agro-industrial development, which could include processing and marketing of fishery products, feeds and equipment for aquaculture, and seaweed culture for the production of marine colloids, pearls oyster culture, etc. (Pillay & Kutty 2005, pp. 14)

This list is provided to illustrate some of the differing uses and goals for developing aquaculture and to demonstrate that the intended outcome is greatly impacted by the socio-economic status of the people in the area. As this paper is interested in the role aquaculture may play in stabilizing outmigration in outport Newfoundland, the 4th and 5th goals are ones that will be more thoroughly examined. However, many of the goals here could also rain true for the Newfoundland region including the 3rd and even 8th as well. In any case, a great understanding of the history, form, and function of global aquaculture developments is necessary before examining the industry in Newfoundland in greater detail.

3.1 History

The aquaculture industry can be said to have been first developed several thousand years ago in Asia. Individuals would harvest carps from freshwater ponds as well as rice paddies (Parker 2002). The aquaculture industry we have today came from this and was developed and expanded upon over time. Table 3 contains a time line which was derived from Fisheries and Oceans (2009a), Parker (2002), Pillay & Kutty (2005), Swann (1992),

and White et al. (2004) and denotes many important dates in the development of the present aquaculture industry at a global and national level.

3.2 The global aquaculture industry (1950 – Present)

The global aquaculture industry has been an important part of the world's total fish production for a long time. This is especially true when examining the changes in this industry's production from the 1950's to present day. As global populations increase, the demand on capture fisheries also escalates. As a result, many fisheries around the world have started to buckle under the pressures of overexploitation. Figure 3 illustrates the global relationship (excluding China) between population growth and fish supply and utilization (consumption and non-consumption) from 1950 to 2004. This figure also illustrates that during this time period, capture fisheries have become increasingly depleted and overexploited. As the global population increases and capture fisheries become more depleted, there will be an increased need for an alternate source of fish products. This alternate source can only come from the aquaculture industry.

According to *The State of the Worlds Fisheries and Aquaculture* report (FAO 2002 & 2010), in the year 2000, the world's population was 6.1 billion. During that year, 94.8 million tonnes of capture fish were produced and 35.6 million tonnes were produced from the aquaculture industry. Nine years later, the world's population increased to 6.8 billion (10% increase), production of capture fisheries decreased from 94.8 to 90.0 million tonnes (4.0% decrease), and aquaculture production increased from 35.8 to 55.1 million

tonnes (35.0% increase). In nine years, aquaculture went from producing 27% of the world's fisheries product needs to producing 38%. Figure 4 illustrates the increase in both capture fisheries and the aquaculture industry from 1950 to 2005. It is interesting to note the change in production proportions during this time. To put the rate of growth within the aquaculture industry into context, production increased by weight by 3.9% in 1970. This increased to 27.1% in 2000 and 32.4% in 2004 and 28.2% from 2004 to 2009. Aquaculture is the fastest growing animal food-producing industry and from 1970 has developed at an average annual rate of 6.6% (FAO 2010). In comparison, capture fisheries only increased by an average annual rate of 1.2 percent and terrestrial meat farms only 2.8 percent per year since 1970. In addition, the consumption of aquaculture products per capita has grown from 0.7 Kg to 7.8 Kg from 1970 to 2008. This again shows a large average rate of growth of 6.6% increase a year. Figure 5 shows the production levels in the major aquaculture species groups from 1970 to 2004.

Aquaculture is presently a very significant source of the world's fish supply. In fact, FAO (2010) indicated that when the weight that comes from the global capture fishery that is for non human consumption is taken into account (around 30 million tonnes), around 50% of the aquatic animal protein consumed by humans now comes from aquaculture and if trends outlined in Figures 3 and 4 continue with respect to population growth and capture fisheries depletion or reaching the maximum sustainable yield as derived from the United Nations (2003) and FAO (2002, 2009, & 2010), the growth of the aquaculture industry will certainly need to increase to meet global demands. Furthermore, it can be expected that this increased reliance in the sector as a result of an increased population

levels and reliance on fish products for consumption will also mean increased levels of employment as the aquaculture industry adapts to increased demand. FAO (2010) indicated that almost 11 million people are employed directly in the aquaculture industry. Furthermore, with employment generated from the fishing sector globally being around 44 million, 33 million from capture fisheries, it is interesting to note that direct aquaculture employment accounts for around 25% of the global employment in this sector. In an area such as Newfoundland and Labrador, the aquaculture industry may greatly increase levels of employment, revenues, and exportable product.

3.3 The Canadian aquaculture industry

The aquaculture industry started in Canada more than 150 years ago with trout farming in British Columbia, Ontario, and Quebec and oyster farming in New Brunswick, British Columbia, and Prince Edward Island. The industry went under further development from 1984 to 1991 in New Brunswick and British Columbia (Fisheries and Oceans Canada 2009b) principally with salmon farming. As indicated in Figure 6, the aquaculture industry has been growing steadily, thanks in large part to the rapid growth in the salmon industry, from 1991 to 2007. Also, according to Statistics Canada (2009), from 1991 to 2007, the outputs from aquaculture increased from 49,000 tonnes to 170,000 tonnes. This growth also aided the Canadian economy by $395.8 million in 2006 and was up 58% from 2005. Also, even though output and the value in the Canadian industry declined from 2006 to 2008 (as indicated by Figure 6) Fisheries and Oceans (2010) indicated that the gross value of aquaculture to the Canadian economy in 2007 was $2.1 Billion.

Employment produced from the aquaculture industry in Canada also shows positive signs and in a 2004 study (Aquaculture in Canada 2008) it was stated that the Canadian aquaculture industry provided direct employment for 5,565 people (one third of which earned between $25-35 thousand a year) and may provide spinoff employment for upwards of 14,000 additional individuals. It was furthermore stated that half of the positions were held by individuals between 21 and 35 years of age and that 80% of the positions created from the Canadian aquaculture industry were full time. Furthermore, as stated in Fisheries and Oceans (2010) 14,495 people were employed in the aquaculture industry (4,895 directly, 6,400 indirectly, and 3,200 induced).

While the aquaculture industry in Canada is dominated by salmon production (accounting for 68.9% total production by volume), species such as mussels, oysters, trout, and other shell and finfish also greatly contribute to the yearly production and value of the industry as illustrated in Figure 7. While it is not surprising that British Columbia holds the largest portion of the aquaculture industry at 47.3%, it is interesting to note that provinces such as PEI, which grows primarily blue mussel, has nearly 12% of Canada's output and Newfoundland and Labrador which farms both salmonids and blue mussels account for 8.1% of Canada's total in 2008 and when the industry increased to $ 92.1 million in 2009, a 18% increase from 2008 and accounted for 11.5% of the total Canadian production. A further increase in production of 12.7% (from 13,627 to 15,360 tonnes) and an increase of 26.1% in value (from $92 to $116 million) from 2009 to 2010 meant that Newfoundland and Labrador's production in 2010 accounted for almost 15% of the

volume produced in Canada (DFA 2009b & 2010a, Fisheries and Oceans 2010), and is currently the third highest grossing province in terms of aquaculture output.

Farming in Canada, like the species that are produced and the location from which they are derived, can take on many different forms. In fact, as Figure 8 illustrates, the aquaculture systems used through Canada greatly depend on the local environment, species intended for production, and may even differ depending on the different stages of the production process.

3.4 The Newfoundland and Labrador aquaculture industry

Like the aquaculture industry in Canada and, indeed, the world, the Newfoundland and Labrador industry has grown significantly in recent years. From 1995 to 2010, production rose from 1,029 tonnes to 15,360 tonnes (an increase of 1,393%) and the value increased 3,264% from $3.448 million in 1995 to $116 million in 2010. (Fisheries and Oceans 1995, DFA 2010a). While this trend is impressive, it emphasizes the growth the industry experienced in the following decade. Moreover, even though there was a 21% decrease in production and 23.5% in value from 2006 to 2007, due to low production and the strong Canadian dollar, production increased 39.1% in 2008 and a further 18% in 2009 (DFA 2007, 2008, and 2009a) due to strong markets for steelhead trout and Atlantic salmon. As Figure 9 (DFA 2010) illustrates, the industry bounced back in 2008 increasing 39.1% in production and 61% in value to $63.1 million. In 2010 production further increased by 12.7% (from 13,627 to 15,360 tonnes) and value increased by 26.1% (from $92 to $116

million). From 1995 to 2010 the industry has increased on average 95% in production and 191% in value a year and has grown from providing full time employment for 370 individuals in 2006 to 684 full time positions in 2010 (DFA 2006b & 2010b) nearly a 85% increase.

Currently, aquaculture is divided into three major species in Newfoundland and Labrador: salmonids (Atlantic salmon and steelhead/rainbow trout) and shellfish (mainly blue mussels). As shown in Figure 10, even though sites are greatly dispersed through the province, there is a trend in their relative placement with salmonid farms being located on the southern coast where water temperatures are generally warmer while shellfish farms are located more along the Northeast coast.

While the aquaculture industry in Newfoundland and Labrador is predominantly salmonid and blue mussel, in the 2000 report (updated in 2002 and 2005) DFA stated that the province is in the process of working on the development of a number of alternate species including Atlantic cod, giant scallop, Arctic char, American eels, yellowtail flounder, and sea urchins. In addition, this report also indicated that further research is being conducted on a number of additional species including Atlantic halibut, wolffish, softshell clams, and seaweeds to determine their potential in the local aquaculture development however, at present, only Atlantic cod, softshell clams, and Arctic char are being aggressively pursued.

As indicated, the Newfoundland and Labrador aquaculture industry has grown significantly in recent years and this trend can be expected to continue for reasons described by a Department of Fisheries and Oceans report in 2006. These included: high water quality, the abundance of usable land and water area, the existence of previously constructed fisheries related infrastructure, an abundance of skilled workforce which could aid in the development of product at differing levels of development (primary, secondary, and tertiary), and the fact that the province is well established with respect to research and development through the Fisheries and Marine Institute and the Oceans Science Centre. Moreover, this report stated that the aquaculture industry has the acceptance of the Provincial government, which provides many incentive programs such as the equity loan program which aims at facilitating the development of local aquaculture sites. Finally, this report indicated that the development of the aquaculture industry in this province is accepted by local communities and is viewed as a priority in the economic development of outport Newfoundland and Labrador.

3.5 Effect of the aquaculture industry in Newfoundland and Labrador

While it is clear that the aquaculture industry is having a significant effect on many regions across Canada (Fisheries and Oceans 2006 and 2010), little is known how it has affected the socio-economic environment for persons and communities in rural Newfoundland and Labrador. To examine this, a short, confidential questionnaire was conducted which was aimed at examining how, and to what extent the local aquaculture industry is affecting local life and, in general, how the downfall in the capture fishery has

affected community life and demographics. No personal information was collected, nor sought, and all responses were aggregated for analysis.

The questionnaire (Appendix B) consisted of three main sections. The first consisted of four questions designed to gather background information regarding the local capture fishing industry, how changes in this industry affected the local area economy, when the aquaculture industry started, and what species were produced. The second consisted of one open question "In what way has aquaculture affected the socio-economic environment of your community with respect to:" with five topics "employment, community growth, availability of goods and services, level of construction, overall sense of well being within the community." The third section asked participants to speculate what growth in the aquaculture industry may mean for their local area. The final question in the questionnaire provided the participant the opportunity to add addition information if they were so inclined.

Five community leaders and eight individuals (two from aquaculture backgrounds and six government employees) whom were involved in the fishing and aquaculture industry in the Northeast coast (Green Bay area) and the South coast (Coast of Bays) were contacted and participants completed the questionnaire either via email, fax, or over a phone interview. Of the individuals contacted, 13 completed the questionnaire representing the communities of La Scie, Roberts Arm, Springdale, Hermitage, Milltown, Belleoram, St. Jacques, Boxey, Coombs Cove, and St. Alban's as well as providing the view of a number of government departments.

As Table 5 illustrates, when it came to the commercial fishery, the response was not surprising. In many communities the fishing industry was, and still is a very important source of economic stability. However, individuals stated the reliance on the fishing industry meant outmigration and loss of employment with the changes in the fishing industry (going from salt cod, to fresh cod, to shellfish) and increased reliance on social assistance. One individual stated that the employment level went from employing 100 to 200 persons down to 50 seasonal employed in his town. In addition, participants indicated that the aquaculture industry started in some areas, up to 30 years ago in the early 1980's while in other areas only in the last five years and that the Green Bay area was dominated with blue mussel farming and the Coast of Bays area with Atlantic salmon with some char and steelhead trout.

When it came to the socioeconomic effect the aquaculture industry has had on the local area, participants' responses were very positive. In fact, the aquaculture industry has provided employment in the Coast of Bays area for around 600 full time and in the Green Bay area around 100 full and part time positions. Participants reported that people are now moving back to the area to work and people are seeing increased levels of disposable income. While it was reported that people are still moving away to Alberta and away for secondary education, some families are moving back. It was reported that rental properties in the Coast of Bays area are at a premium and there has been an increase in housing projects in St. Alban's, Conne River, Harbour Breton, St. Jacques-Coomb's Cove, and Milltown and with the development of wharves, floating docks, etc, commercial construction in the area is also up significantly. Furthermore, some

individuals that were involved in the commercial fishery have now found employment in the aquaculture industry and some even have supplemented their fishing income by working part time in the aquaculture industry.

When it came to the availability of goods and services, it was reported that while there was some improvements at the local consumer level (fresher and greater availability of products) it is at the commercial level that the service industry has increased with the opening of diving companies, hydraulic and small engine repair stores, etc. In general, it is felt that the aquaculture industry has played a very significant part in the stability and improvement of the socioeconomic climate of their local area. It was stated that because individuals now have more disposable income, they are able to put that back into their houses, local community, into their children's education which all increases a sense for town pride and a belief in the stability of their employment and economic future.

Interestingly, when it came to the future outlook for the aquaculture industry, participants from the Green Bay area responded differently to those from the Coast of Bays area. For the most part, everyone was optimistic regarding the future but individuals from Green Bay felt that the industry there may have reached its limit and without changes in marketing/processing of their product, and that the issues regarding resource usage are addressed, the industry there will not grow. However, it was generally felt that if the markets remain good, they should have a positive future.

In the Coast of Bays area however, while it was recognized that the future may bring difficulties, the people there are very optimistic. In an area that is now producing around 12,000 tonnes of product, it is believed that over the next five years, this will increase to 40,000 tonnes. It is hoped that this will increase the number of full time employment from 600 persons to 1,200 and will further decrease outmigration.

Section 4: Discussion

When discussing the topic of aquaculture as a means of rejuvenating local economies by providing meaningful employment to individuals in the local area, it is necessary to examine the factors that greatly impact the sustainability and viability of the venture. Significant planning is required to determine the feasibility of a site prior to development and will greatly reflect on the projects level of success. In general, there are three major factors that determine the success of a site. These are: 1) the species being farmed, 2) the methods used to farm the selected species, and 3) the location selected to implement the site. Each plays a critical role in the success, and respectively, the ability of the farm to provide meaningful employment for local workers. As such, the species outlined in the DFA (2000) will be discussed in general with more emphasis being placed on the two major species now dominating the aquaculture industry in this province, Atlantic salmon and blue mussel.

As discussed in the DFA (2000), even though there are a number of research & development species, there are only three major commercial aquaculture species in

currently in production (Atlantic salmon, steelhead trout, and blue mussels). While production of the research and development species listed above may be significant in the long term, currently, as of 2007 the three commercial species represent 100% of the yearly production from provincial aquaculture farms, hold 82% of the licenses, and approximately 89% of the water used for provincial aquaculture production (DFA 2007). Unlike the research and development species, these commercial species play a critical role in the current value of the aquaculture industry. As well, if current trends in global markets continue, the farming of these species will also play an important role in the future of aquaculture this province and to the survival of outport Newfoundland and Labrador.

4.1 Atlantic salmon

In the wild, Atlantic salmon can be found on both sides of the North Atlantic where they can spend four years feeding on pelagic species in the deep sea feeding grounds. Once mature, Atlantic salmon stop feeding from October to January and travel back to the rivers where they spawn and eventually hatch as fingerlings (FAO 2011a, Pillay and Kutty 2005).

In an aquaculture system, the process of growing Atlantic salmon (Figure 11) mimics that of the growth of wild salmon. This process can be broken down into three stages of development: seed supply, nursery, and ongrowing.

During the seed supply stage of development a broodstock or mating stock is selected from sea site stocks (a location where adult salmon are held to grow before going to market) and are usually moved to freshwater tanks two months prior to stripping.

Once the eggs hatch and the alevins absorb their yoke salk, the now fry continue to grow in nurseries into parr and finally smolts which are capable of living in sea water. Once the salmon are between 40 to 120g in weight and it is determined that they can survive in a seawater environment, they are transported to a cage aquaculture site. These sites are selected for their suitability regarding water temperature which must be between 6 and 16°C and have salinity between 33 and 34 ‰ with a water flow capable of eliminating waste and oxygenating the water to approximately 8 ppm. Outgrowing occurs at sea sites for up to two years with a maximum stocking density of 20 kg/m^3. Harvesting usually occurs when salmon are 2kg or greater. The global production of Atlantic salmon, as Figure 12 indicates has been increasing at a steady rate from the early 1990's (FAO 2010). If this trend continues, one can expect the demand for Atlantic salmon aquaculture to also increase in Newfoundland and Labrador as well as globally.

4.2 Blue mussels

Blue mussels are a circumglobal species which can be found from the Russian White Sea to the Southern France coast in the Atlantic and are distributed widely due to their ability to live in areas with great fluctuations in water temperature, salinity, and oxygen levels

(FAO 2011b). In fact, blue mussels can survive in waters with a salinity as low as 18 ‰, although their size is reduced. Blue mussels tend to do well in waters up to 40 ‰ salinity. As Figure 13 illustrates, blue mussel aquaculture may be undertaken using a number of culturing methods (on-bottom, bouchot, raft, and longline). This is due, in large part, to the mobility of the mussel larvae during early development. The culture techniques are greatly influenced by the availability of freely dispersed blue mussel larvae. Nonetheless, a hatchery can be used to ensure the reliability of a stock.

The global market for farmed blue mussels has been growing significantly since the 1950's (FAO 2011b). In fact, as Table 4 illustrates, the global production of mussels is now estimated to be around 1.625 million tonnes in 2008 (FAO 2008).

5. Conclusions

This paper aims to examine how, and in what capacity, the future aquaculture industry in Newfoundland and Labrador may prevent or mitigate the depopulation of the province in two ways. The first is to examine its ability to provide a sustainable economy for outports. The second by being a means to reduce or eliminate the displacement of individuals that move both due to the "brain drain" phenomena and those that are forced to move due to the lack of fisheries related employment as the industry becomes more rationalized through the possible implementation of an ITQ management regime. When examining these issues, it becomes clear that many important factors must be taken into account, some of which can be controlled, some cannot. Others still are totally dependent

on what the environment can provide. Establishing a successful aquaculture site is a delicate balancing act between many factors that can produce even more challenges. These challenges can come from issues stemming from the species selected, the method used to farm the species, the local environment, and in Newfoundland and Labrador, this is a major factor to contend with.

Currently the province of Newfoundland and Labrador utilizes three commercial aquaculture species (DFA 2010a, Fisheries and Oceans 2010, & Statistics Canada 2009), each of which requires different climates/environments to be sustained. This factor alone has the potential to be problematic when looking at where outports are located around the province and also when taking into account their small populations. In addition, some farms only provide seasonal employment. It would not be unexpected that a seasonal aquaculture site such as this would do little to combat the outmigration of individuals when, as shown earlier, seasonal fishing employment is failing to prevent youth from moving to areas with greater year round permanent employment. However, even with the presence of such restraints and limitations, one can find many accounts where the implementation of an aquaculture site has proven successful at rejuvenating the local economy while providing meaningful employment for those just entering the workforce. Such examples can be seen in the blue mussel industry in PEI and the Atlantic salmon industry in Charlotte County, New Brunswick (Fisheries and Oceans 2006 and 2010).

As discussed in Fisheries and Oceans 2006a, 2006b, and 2010, the blue mussel industry in PEI can be seen as an example of how fish farming can provide economic benefits at

local and provincial levels. This can be seen in the rate of growth in production, value, and employment produced from the industry over the past 13 years preceding 2004. As stated in 1992, the industry was estimated to have produced 9.2 million pounds increasing to 40 million lbs in 2004. In fact, the blue mussel production in PEI as of 2006 accounted for 80% of the North American market for fresh mussels. Furthermore, when taking into account sales from direct, indirect, and spinoff employment, the industry generated $106.7million in 2006. Employment generated from this industry is also significant and represented 622.2 person years or, the number of years one individual could continually work (derived from direct, indirect and spinoff employment created from the industry). Finally, the blue mussel industry in PEI contributed $36.3 million to the Gross Domestic Product of the province and generated $3.9 million in Federal and $3.5 million in provincial tax.

The growth of the PEI blue mussel industry and its importance in the provincial employment and economy is significant when examined in a socio-economic context. The industry has become a significant force in the North American market and as a result, provided meaningful employment to hundreds of individuals. This success story exemplifies the ability of aquaculture to provide employment to local areas and how it can rejuvenate local economies.

In Charlotte Country, New Brunswick, Atlantic salmon farming helped create 3,000 full time jobs either directly or indirectly and holds 25% of the local workforce. The industry here provided $273 million in revenues and during development, $150 million was spent

developing the local economy to accommodate the salmon farming and a further $33 million was infused into the local economy through income from those that are employed in the industry. This area can be said to be thriving and that salmon farming is a significant driving force behind this.

One can find many examples of how the development of an aquaculture site has proven fruitful economically on a local and provincial scale (Fisheries and Oceans 2006a & 2010). However, the ability of the aquaculture industry to turn the tides, so to say, of the outmigration in Newfoundland and Labrador and rejuvenate all the rural and outport communities is another matter. Environmental constraints, such as the seasonal water temperatures, and the location of the majority of the coastal communities in this province are a major limiting factor and will greatly limit the species that can be farmed and the areas where the farming can take place. Because of the dispersed nature of the settlements in Newfoundland and Labrador, as a result of the pressures placed on earlier settlers discussed above, it will be very difficult to create localized sites that will provide optimal employment and economic benefits over a large area. Furthermore, as previously discussed, the youth of this province are not leaving due to lack of employment; they are migrating due to a lack of suitable full-time permanent employment. The implementation of a farm that can provide primarily this type of employment, while it may provide greatly to the local economy, will do little to stem the flow of individuals out into the larger centers. Finally, if an ITQ system of management is put into place in the fishing industry in Newfoundland and Labrador, it is predicted that the vast transfer of licenses will be mirrored by an equal migration of the individuals in coastal Newfoundland

Labrador in a very short time frame. One must question if it is possible for any one industry to be able to divert the thousands of individuals that will be migrating out of hundreds of different small coastal communities.

While this paper aimed to provide a background to these issues, further investigation can be conducted to examine this issues and predictions. While the ability of the aquaculture industry to rejuvenate outport Newfoundland and Labrador by providing meaningful employment may be questionable on the large scale, it can provide a stable, sustainable base from which the economies of localized areas can be rejuvenated as seen in the Green Bay area and Coast of Bays region in Newfoundland and Labrador.

Newfoundland and Labrador has seen considerable changes since its discovery some 500 years ago by Europeans. Over time as the fishing industry changed from salt cod to fresh frozen to shell fish, the demographics shifted in turn. Current fisheries are no longer capable of sustaining the outports that were developed when the industry was a communal affair. As a result, many of our outports are now becoming less populated. As out migration continues, so will the possibility that Government may see in prudent to institute a present day resettlement program. In fact, evidence of this can be found in the community of Harbour Deep.

Harbour Deep was the first community resettled since 1975, and since that time the population began to dwindle. In 2002, 120 people were asked to move because the economy in that area no longer existed (this area had a big reliance on the cod fishery),

and the community was basically isolated. In the end, the government of Newfoundland and Labrador granted $100,000 to each family who moved (Mayda 2004).

One important point to take from the Harbour Deep example is how it mirrors the resettlement of the hundreds of communities only 50 years before. Also, like in the past, government coerced individuals to move by stating that if the population became too scarce, government support (such as road clearing, mail delivery, schooling, etc.) would be cut off. Perhaps it is not that great of a conjecture to think that Harbour Deep was resettled solely because it no longer had the population for government to rationally provide government support.

It seems that Newfoundland and Labrador has had its share of changes and challenges in the fishing industry in the past 500 years. If global trends continue, the aquaculture industry may be the next phase in the life of this province, although it will undoubtedly have the ability to save some local regions of outport Newfoundland and Labrador, it is uncertain that it could ever have the means to sustain and provide for the hundreds of scattered communities that cover the outer regions of this province. However, in those areas where the aquaculture industry has been developed, like in the Coast of Bays area, it is evident that this industry has, and will continue to provide a significant source of meaningful employment to the region. It is also evident that the aquaculture industry does have the ability to provide employment for harvesters who are displaced from the fishing industry and it has, in some locations, rejuvenated outport/rural communities in Newfoundland and Labrador.

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Appendix: A
Tables and Figures

Table 1: Breakdown of In/Out-migration changes from 1991 to 2006 in Newfoundland and Labrador (Taken from Statistics Canada, 2009.)

Province	In-migrants		Out-migrants		Net migration 2001 to 2006	Net migration 1996 to 2001	Net migration 1991 to 1996
	number	percentage	number	Percentage	Number		
Newfoundland and Labrador	...	...	...	...	...	...	...
Prince Edward Island	365	1.4	455	1.4	-90	-610	-595
Nova Scotia	3,635	14.1	4,255	13.3	-620	-4,065	-3,240
New Brunswick	2,895	11.2	1,350	4.2	1,545	-1,315	-1,720
Quebec	760	2.9	975	3.0	-215	-150	-270
Ontario	10,160	39.4	9,060	28.3	1,100	-11,000	-6,675
Manitoba	1,750	6.8	705	2.2	1,045	-350	-500
Saskatchewan	240	0.9	600	1.9	-360	-570	-110
Alberta	4,115	16.0	11,355	35.5	-7,240	-11,580	-4,915
British Columbia	1,385	5.4	2,220	6.9	-835	-785	-4,380
Yukon	55	0.2	30	0.1	25	-40	-275
Northwest Territories	135	0.5	610	1.9	-475	-345	-565
Nunavut	280	1.1	400	1.2	-120	-230	...
Total	25,775	100.0	32,020	100.0	-6,245	-31,040	-23,235

Table 2: Migration rates per age group for Newfoundland and Labrador from the 1996 to 2001 (Taken from Statistics Canada, 2001).

Age group	In-migrants	Out-migrants	Net migration [1]	
	Number			Rate (%)
5-14	2,885	6,250	-3,365	-5.0
15-29	4,125	22,000	-17,875	-14.8
30-44	5,570	12,900	-7,330	-5.8
45-64	2,945	5,195	-2,250	-1.6
65 and over	575	755	-180	-0.3
Total	16,060	47,115	-31,055	-6.1

(1) Difference between the number of incoming and outgoing migrants from internal migration.

Table 3: History of the development of the global aquaculture industry

A timeline denoting some of the important developments and achievements over the past 5,500 years that influenced the present global and Canadian aquaculture industry. (Taken from Fisheries and Oceans 2009a, Parker 2002, Pillay & Kutty 2005, Swann 1992,White 2004).

3500 BC:

- Aquaculture first started in China through the growing of carp in rice paddies and in freshwater lakes.

2500 BC:

- There is evidence that Egyptians were farming tilapia.

2000 BC:

- Japan developed aquaculture raised oysters.

475 BC:

- The oldest known document on aquaculture was written by Fan-Li which described aquaculture pond construction methods as well as other concepts important in the maintenance and development of an aquaculture site.

618:

- The concept of polyculture aquaculture was discovered. This occurred because the farming and eating of the common carp was banned because it shared its name with the Emperor at the time (Li). Emperor Li stated that anything that shared his

name was sacred. This band led to the understanding that multiple species could share a common water location where there is no competition for food or space and lead to the farming of 4 different species of carp.

746:

- The concept of clam aquaculture appeared in Chinese writing.

1400:

- Indonesia began catching small milkfish during high tides in local coastal ponds. This is believed to be the start of the aquatic finfish aquaculture industry.

1600s:

- Seaweed aquaculture appears in Japan.

1733:

- A farmer in Germany was successful at raising trout to maturity from eggs that was found and fertilized by hand. The beginning of modern aquaculture.

1800s:

- It was realized in France that it is possible to transport oyster larvae which settled on tiles to a protective area to grow.
- In addition, the United States of America (US) started to farm oysters.

1857:

- Hatching and incubation was studied in Atlantic salmon and trout in present day Quebec.

1865:

- Oyster aquaculture started in Prince Edward Island.

1874:

- Rainbow trout were brought to all the continents (except Antarctica) which were intended for aquaculture and recreational angling.

1880s:

- New England aquaculturists study the ability to farm other species (lobster and flounder).

1889:

- A cod hatchery was developed on Dildo Island which ran until 1897 in which time it released in excess of 1 billion fry in the waters around Newfoundland.

1910:

- The U.S. hatcheries develop techniques for raising channel catfish.

1920s:

- Pacific oysters began in British Columbia to replace overharvested natural oysters.

1930s:

- Research in Japan resulted in a significant advancement in shrimp aquaculture.

1950s:

- In Canada, around 750 million salmon and trout are produced from provincial and federal hatcheries for stock enhancement and for sport fishing.
- The aquaculture industry in Canada began gathering wild young shellfish which grow to market size in a controlled environment.

1960s:

- Research began in Canada on shellfish aquaculture.
- Japan established a commercial shrimp aquaculture.
- Norway and Scotland develop the first commercial aquaculture salmon farms.

1970s:

- Due to research and development into trout and salmon farming by Fisheries and Oceans Canada, commercial farming began on a large scale. Aquaculturists seek deep waters similar to those in the Norwegian fjords. On the East coast of Canada, farming first started in the Bay of Fundy in New Brunswick where the 28' tides

and immaculate waters coupled with the protection of the area made it an exemplary location. On the West Coast of Canada, Chinook, Sockeye, and coho farms were developed on the Sunshine Coast.

1976:

- It is estimated that the global aquaculture industry produced 6.1 million tonnes.

1984:

- Global aquaculture industry provided 12 percent to the global food supply (aquatic) and has grown to 10 million tonnes.

1990s:

- Global aquaculture production grows to 13 million tonnes.

- There is a switch in Canada from small independent to group or consolidated ownership of aquaculture sites. Most are still family-owned businesses however.

- Infestation from sea lice, believed to be the result of salmon aquaculture causes the collapse on the sea trout fishery in Ireland.

- Wild fisheries are protected from commercial netpen aquaculture farming in Alaska through bans.

- Disease in shrimp aquaculture resulted in the industry collapsing in many areas globally.

1994:

- It is estimated that the aquaculture industry had grown by means of production 11 percent yearly over the past decade.

1995:

- A moratorium is placed on the development of new salmon aquaculture sites in British Columbia for the purpose of conducting an environmental assessment on the industry.
- Production in the aquaculture industry becomes 24 million tonnes a year.

1999:

- Growing numbers of salmon escaping from aquaculture pens in British Columbia results to the provincial Salmon Aquaculture Policy Framework.
- The Aquaculture industry in Canada is valued at $558 Million and produced 113,250 tonnes of product.
- The global aquaculture industry was estimated to have grown 154 percent in the 1990s and produced 33 million tonnes a year. Aquaculture made up almost 33 percent of the worlds food supply (aquatic).
- Farmed salmon production was now greater than that produced from wild salmon fisheries.

2000s:

- Canada has over 6,000 aquaculture licenses in operation.

- In Canada, 14% of the fish produced, 33% of the total value comes from aquaculture. In addition it is estimated that 16,000 Canadians are being employed through the industry.

2006:

- The aquaculture industry in Canada was estimated to have a value of $961 million from 181,495 tonnes of product.
- The level of escapes from aquaculture sites in Canada, with the use of improved standards for equipment and practices, auditing via outside group, and escape recapture planning, the number of escapes reported in the aquaculture industry was negligible.

Table 4: Global aquaculture production of mussels from 2002 to 2008 (Taken from FAO 2008).

Species group	2002	2003	2004	2005	2006	2007	2008
Mussels							
Capture Fisheries 1,000t	225	187	189	136	114	111	87
Aquaculture 1,000t	1,552	1,622	1,670	1,718	1,814	1,597	1,625

Table 5: Questionnaire results

1) How important was/is the commercial fishing industry to the local area?

- Important, main source of employment in many communities
- Was the reason why many areas were settled
- Some areas it was the forestry industry that was important
- Depending on area, people harvested lobster, groundfish, snow crab, shrimp, etc

2) With the down turn in the fishing industry, how has the local area been affected?

- After the moratorium, in areas that had a high dependency on the fishing industry, experienced high levels of out migration
- Out migration to Alberta and Ontario
- Schools shut down
- Employment in local processing plants became reduced (Triton reduction from 100-200 down to around 50 employees) however, there was some rebound when the shellfish industry expanded
- Increased social assistance through employment insurance and make work projects

3) When did the aquaculture industry start in your area?

- Started in some areas up to 30 yrs ago in the early 1980's but the industry has significantly expanded since 2005 in the Coast of Bays region with the investments from Cooke Aquaculture
- In the Green Bay region, the blue mussel industry started in the late 1980's early 1990' however, do to marketing and processing issues, it is felt that the industry is in a state of limbo

4) What species are being produced?

- Coast of Bays region: Atlantic salmon, steelhead trout, Arctic char, and blue mussel
- Green Bay region: Blue mussel

5) In what way has aquaculture affected the socio-economic environment of your community with respect to:

- Employment?

- Greatly
- Has slowed outmigration in most areas

- Some individuals are moving back to find employment
- Coast of Bays: 600-700 full time positions
- Green Bay: around 100 part time and full time positions
- Harvesters moving to work full time in the aquaculture industry
- Harvesters working seasonally in the aquaculture industry to supplement yearly returns
- Increase in yearly income compared to income from fishing industry
- Creations of spinoff employment from the aquaculture industry
- Due to increased incomes found in the aquaculture industry, some individuals children felt it was possible to attend secondary educational institutes

- Community growth?

- Outmigration still a factor but it has slowed
- See people willing to move into the area and rent/build houses
- The need for houses/apartments has increased significantly
- Has provided stability in community population

- Availability of goods and services?

- Individual level: availability of goods in the super markets have increased in quality and variety
- Commercial level: Establishment of aquaculture related business (Diving, welding, small engine repair, transportation, etc)

- Level of construction?

- Growth in the construction of the residential market as seen with the issuing of building permits in 2009:
    - St. Alban's (6), Conne River (6), Harbour Breton (6)
- Growth in the Commercial market as seen with the issuing of building permits in 2009:
    - St. Alban's (1), Conne River (1), St. Jacques-Coombs Cove (1)
- Growth and or improvements to infrastructure (wharves, roads)
- Hatchery building in St. Alban's
- Processing plant built in Conne River
- Daycare started in Harbour Breton

- Overall sense of well being within the community?

- Coast of Bays:
    - A significant change from the early 2000's when the area it was felt that their communities would not survive
    - People now very prideful in their community
    - Have higher levels of disposable incomes and are using this to improve their homes, communities
    - Recognition from around the world regarding the success of the local aquaculture industry
    - A general feeling that the aquaculture industry has, and is significantly affecting the local economy

- Green Bay:
    - Some sense of stability in the industry
    - While the mussel industry has provided a significant number of jobs in the area, it seems that the regional effect is not the same as in the Coast of Bays area
    - In this area, it seems that people not directly employed from the industry do not see local benefits

6) How do you expect the growth in the local aquaculture industry to affect the socio-economic future of your community?

- Coast of Bays:
    - Very optimistic
    - The industry here is expected to grow to produce 40,000 tonnes (up from around 13,000 tonnes in 2009)
    - This increase in production is hoped to mean as increase in employment (from around 600 to 1,200 full time positions)
    - With this growth, it is hoped that outmigration will stop and the area will see an increase in people moving back to the area

- Green Bay:
    - There is a concern that due to market forces and a lack of processing capabilities in the area, the mussel industry is not expected to grow in the near future
    - Individuals here would like to look into bring in other farm species

- Participants, are optimistic that is market prices remain constant, the future looks bright

7) Do you have any other comments or questions regarding the purpose or any aspect of this study?

- A feeling that if it was not for the aquaculture industry, many communities would have high levels of out migration and reliance on social assistance
- A realization that while the aquaculture industry is important, it will never replace the traditional capture fishery
- Both the capture fishing industry and the aquaculture industry have to work through to deal with usage issues

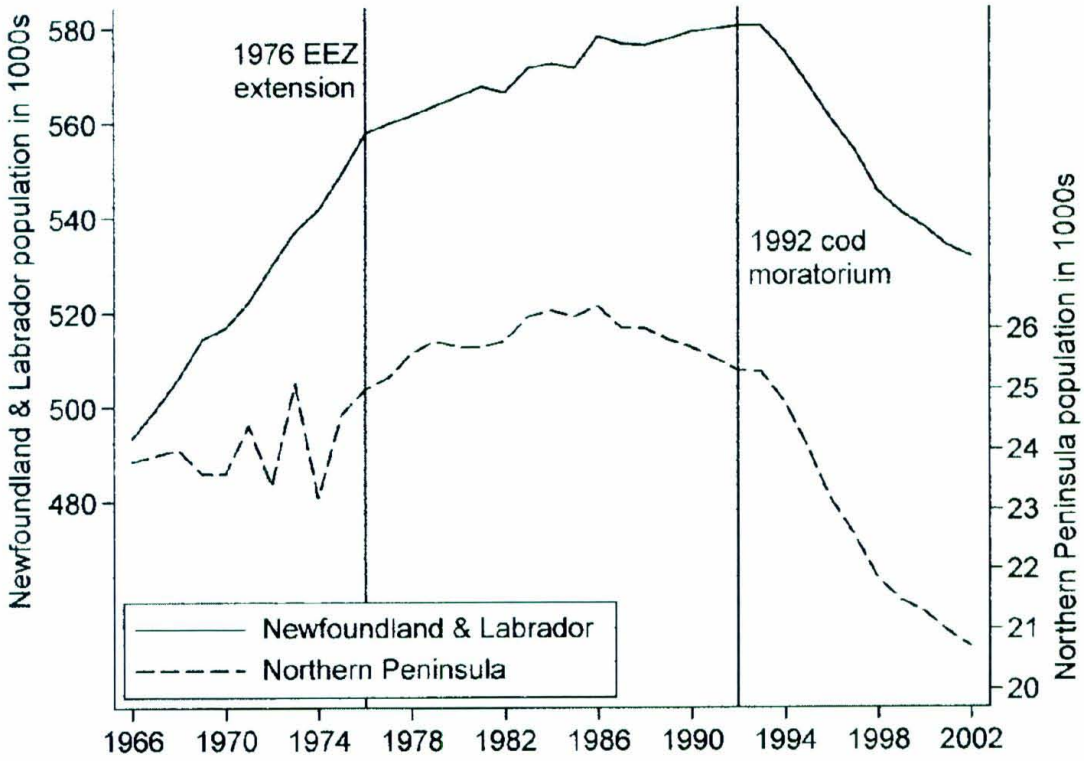


Figure 1: Population levels of Newfoundland and Labrador and the Northern Peninsula. (Taken from Hamilton, Haedrich, and Duncan, 2004).

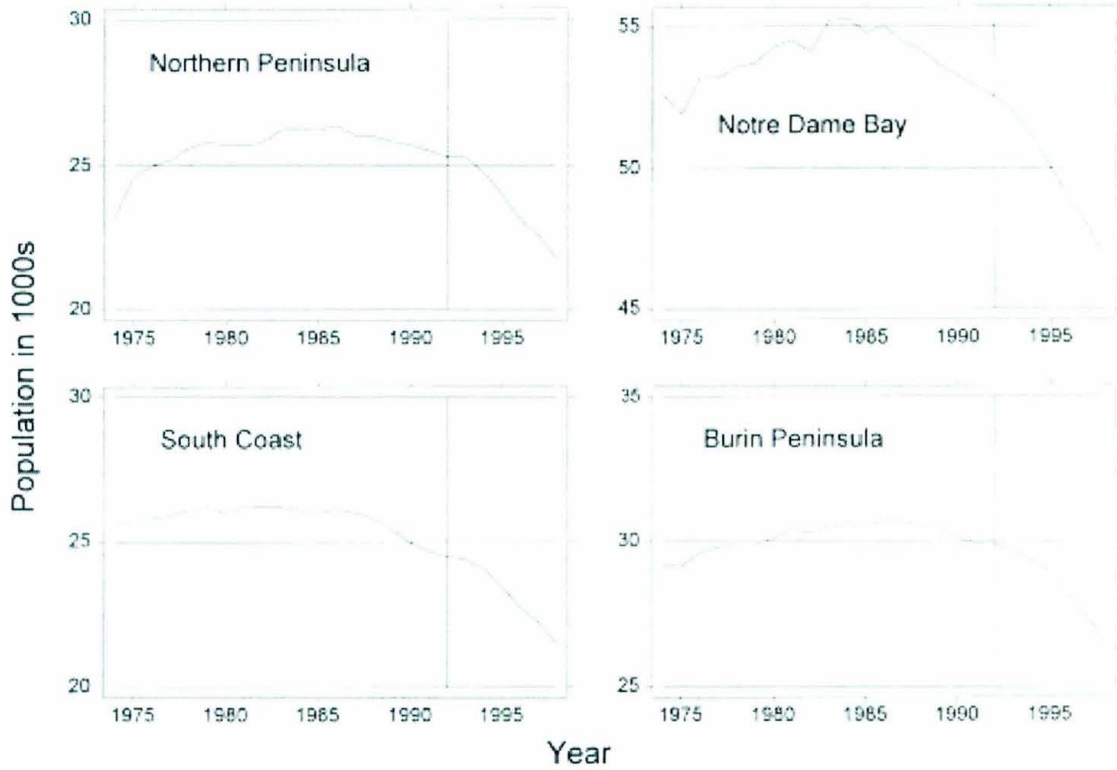


Figure 2: Populations levels in four regions of Newfoundland and Labrador (Taken from Hamilton and Butler, 2001).

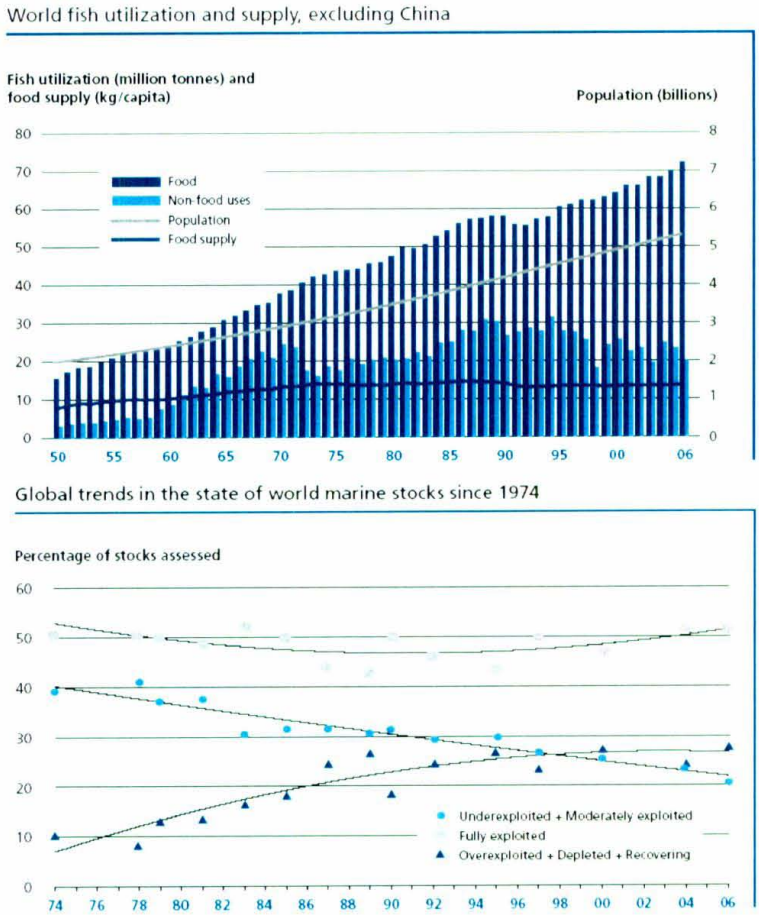


Figure 3: The change in human population, food consumption and exploitation of global capture fisheries (Taken from FAO, 2010).

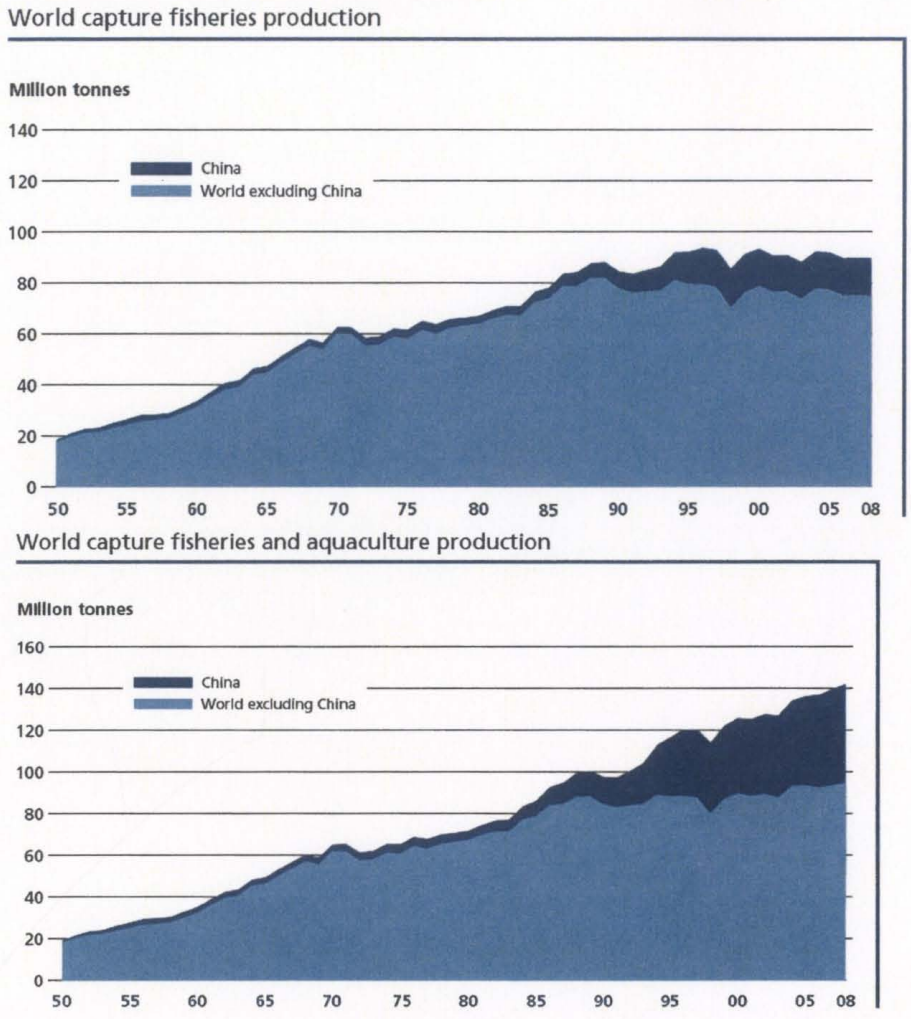
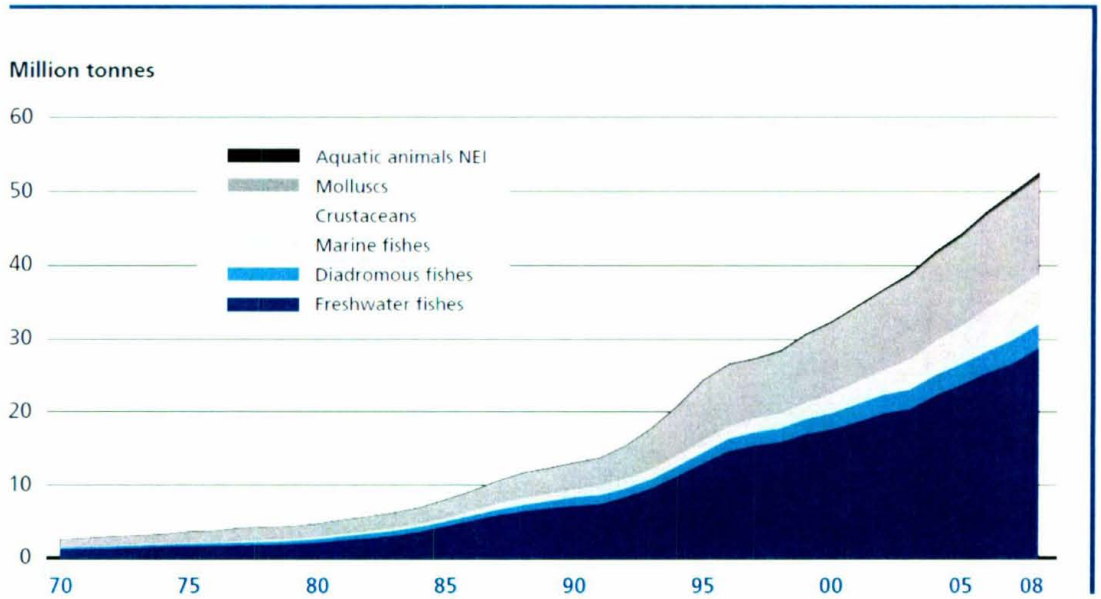


Figure 4: Growth in the global capture and aquaculture industry 1950-2005 (Taken from FAO 2010).



Note: NEI = not elsewhere included.

Figure 5: Growth in the global production of several farmed groups (Taken from FAO 2010).

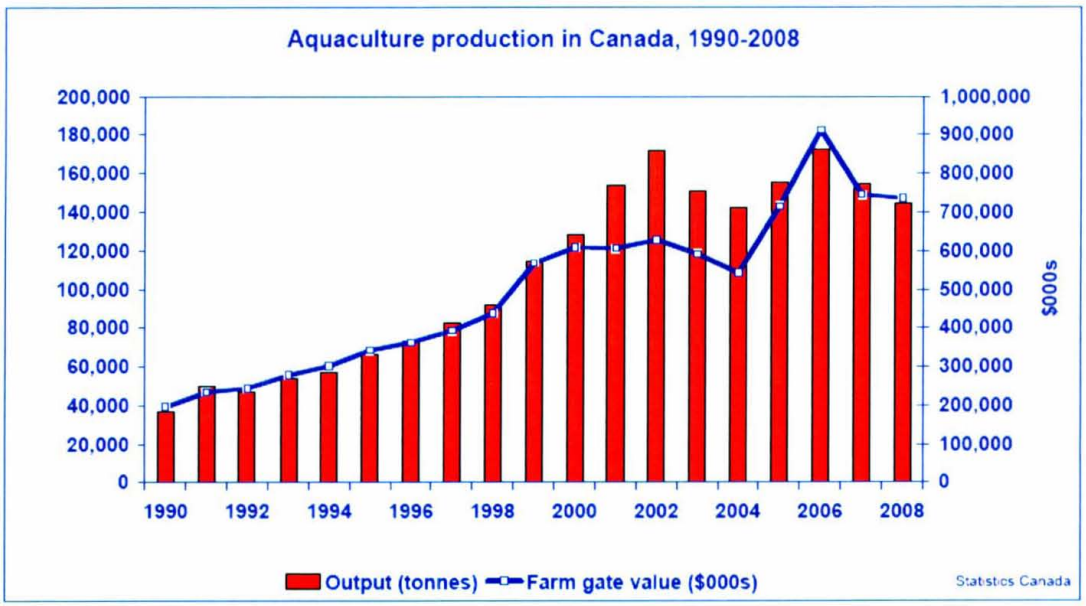


Figure 6: Growth of the Canadian aquaculture industry 1991-2007. (Taken from Fisheries and Oceans, 2010).

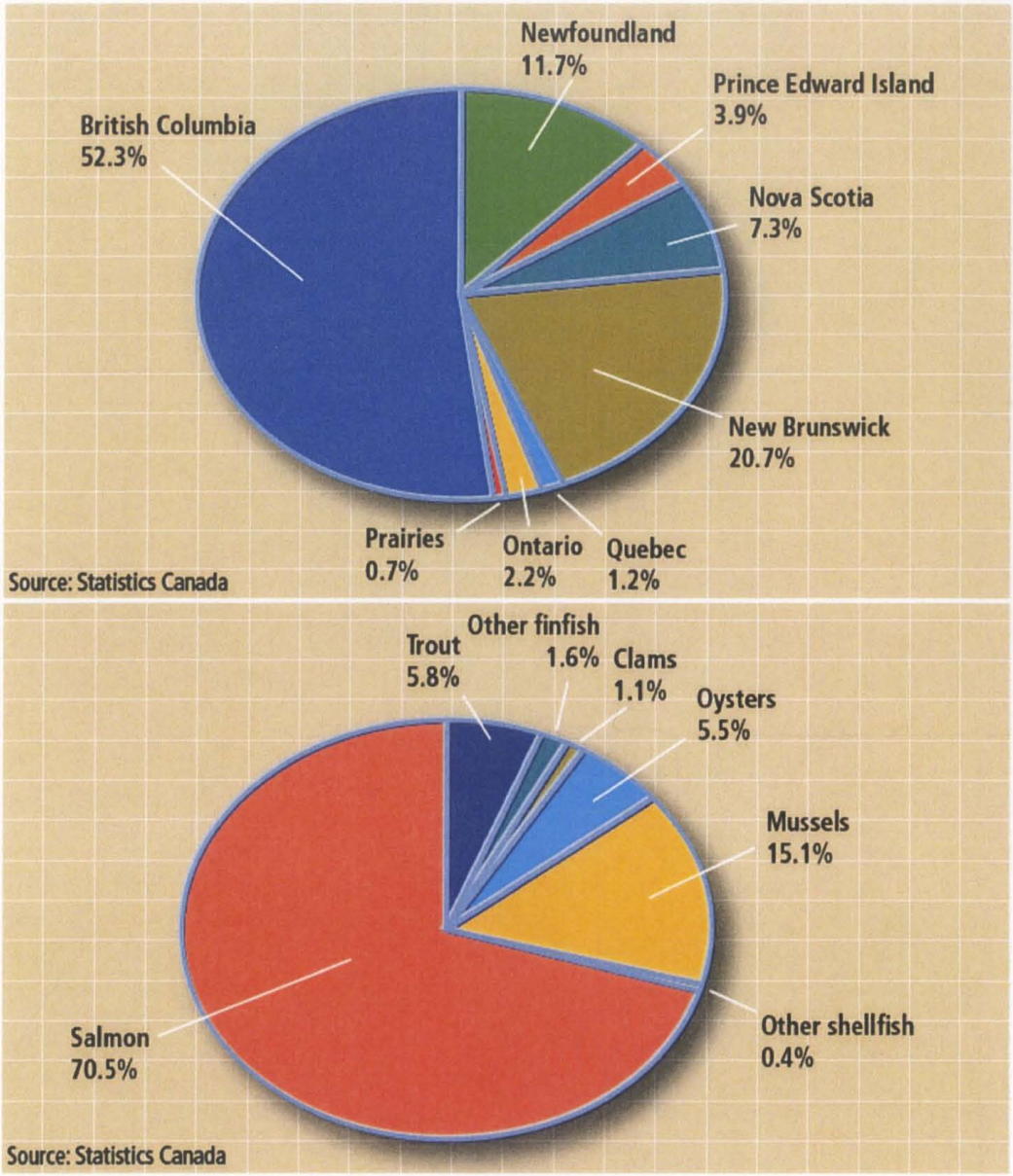
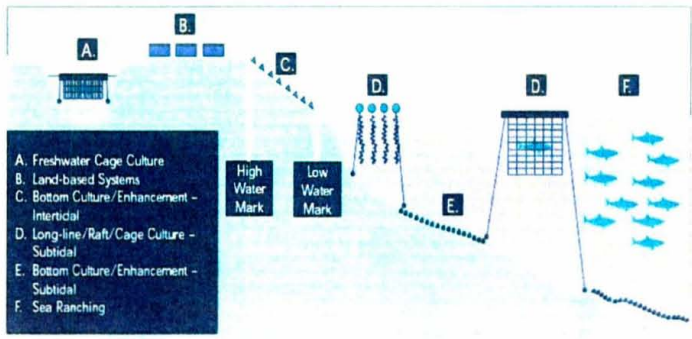


Figure 7: Canadian aquaculture production in 2009 by species and province (Taken from Fisheries and Oceans, N.D.).

Scope of Aquaculture Activities in Canada



(A) In **freshwater (lake) cage culture** operations, hatchery-produced fish are grown in floating cages in public waters under provisions of a lease or permit from the province. Species – trout.

(B) In **land-based systems**, hatchery-produced stocks are grown in tanks or ponds located on private property. Species – trout, charr, tilapia, sturgeon, halibut.

(C) **Bottom culture and enhancement activities in the intertidal zone** consist of two distinct activities; (i) marine plants or sessile shellfish are managed under provisions of a lease; or (ii) marine plants or sessile shellfish are managed without a lease, and a fishing licence is required for harvesting. Species – oysters, clams.

(D) **Long-line and/or cage culture operations** in sub-tidal waters consist of ropes, trays, rafts or net-cage systems that are anchored to the seabed. Such systems operate within the provisions of a provincial or federal lease. Species – mussels, oysters, scallops, salmon, trout, sablefish (black cod), cod, halibut, marine plants.

(E) **Bottom culture and enhancement operations within the sub-tidal zone** are virtually identical to bottom culture and enhancement activities in the intertidal zone. The principal difference is the location of the activities in the coastal zone and the governing jurisdictions related to the activities. Species – clams, scallops.

(F) **Enhancement and/or sea ranching** operations utilize the sea as an aquatic pasture where the hatchery-reared fish are released, forage for food and seek shelter. To facilitate recapture, sea ranching is commonly conducted with migratory stocks, such as salmon, that return to their natal streams to spawn. Sea ranching is a specific form of aquaculture that is used to supplement wild stocks with hatchery-produced fish. Examples include the Salmonid Enhancement Program and the Alaskan culture-based salmon fishery.

Figure 8: The various locations and methods of aquaculture across Canada (Taken from Fisheries and Oceans Canada, 2009a).

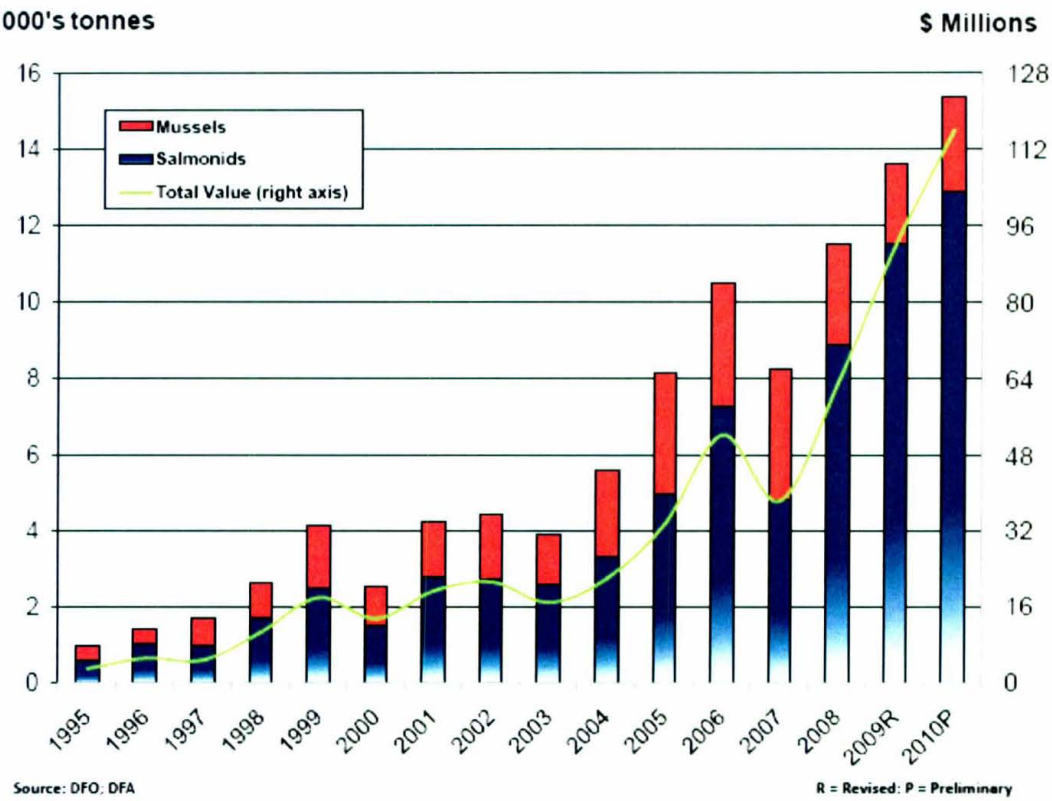


Figure 9: Production and value of Newfoundland and Labrador's aquaculture industry from 1995 to 2010 (Taken from DFA, 2010a).

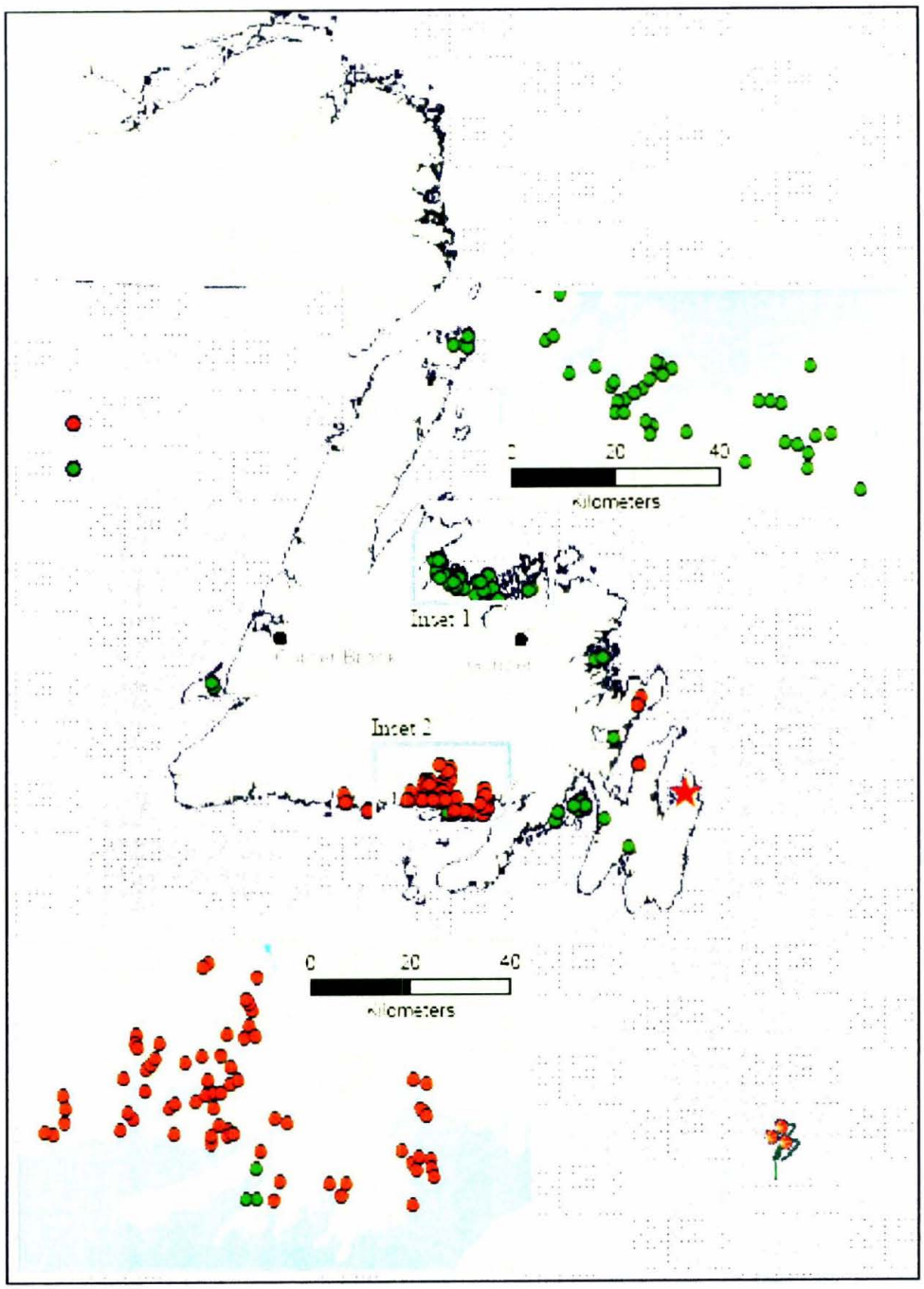


Figure 10: Distribution of salmonid and shellfish aquaculture licenses in Newfoundland and Labrador. (Taken from DFA, 2009).

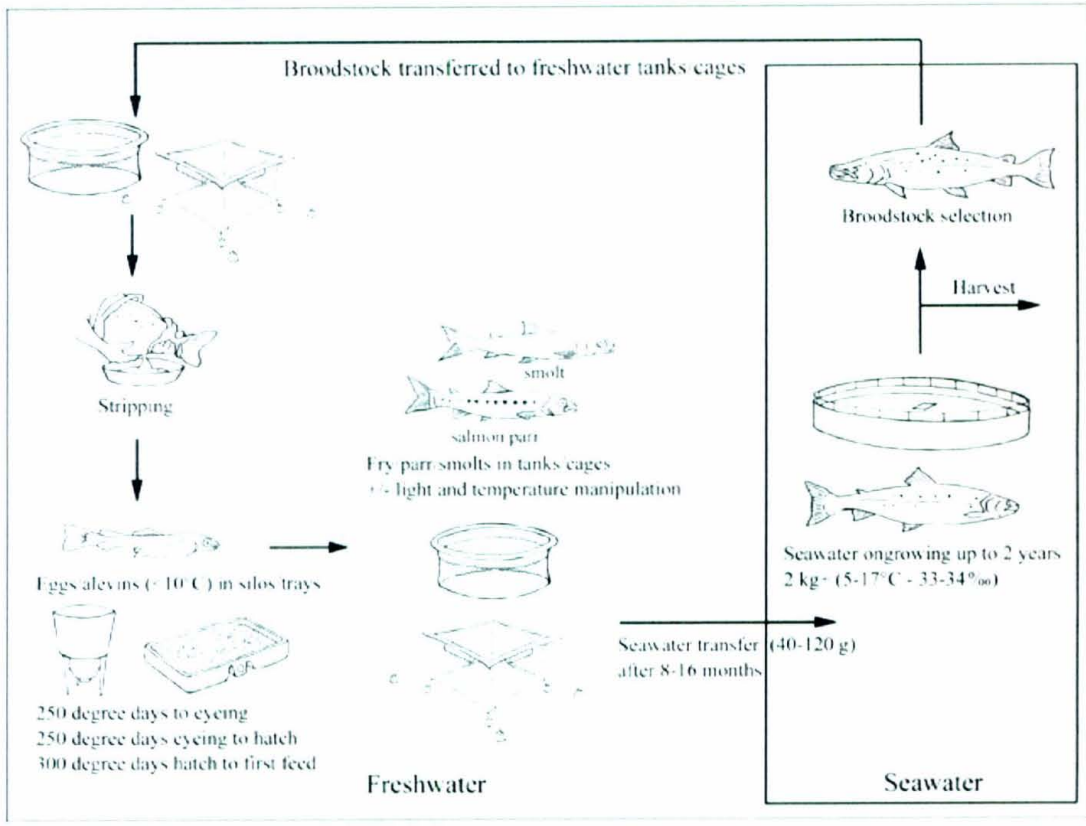


Figure 11: Production of Atlantic salmon (Taken from Taken From FAO, 2011a).

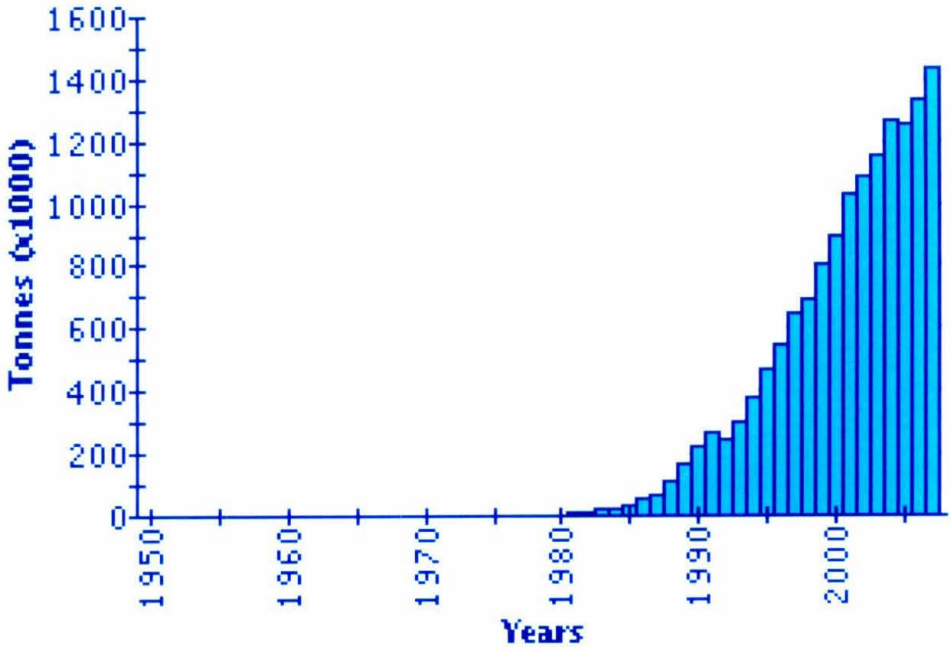


Figure 12: Global production of farmed Atlantic salmon (Taken from FAO, 2011a).

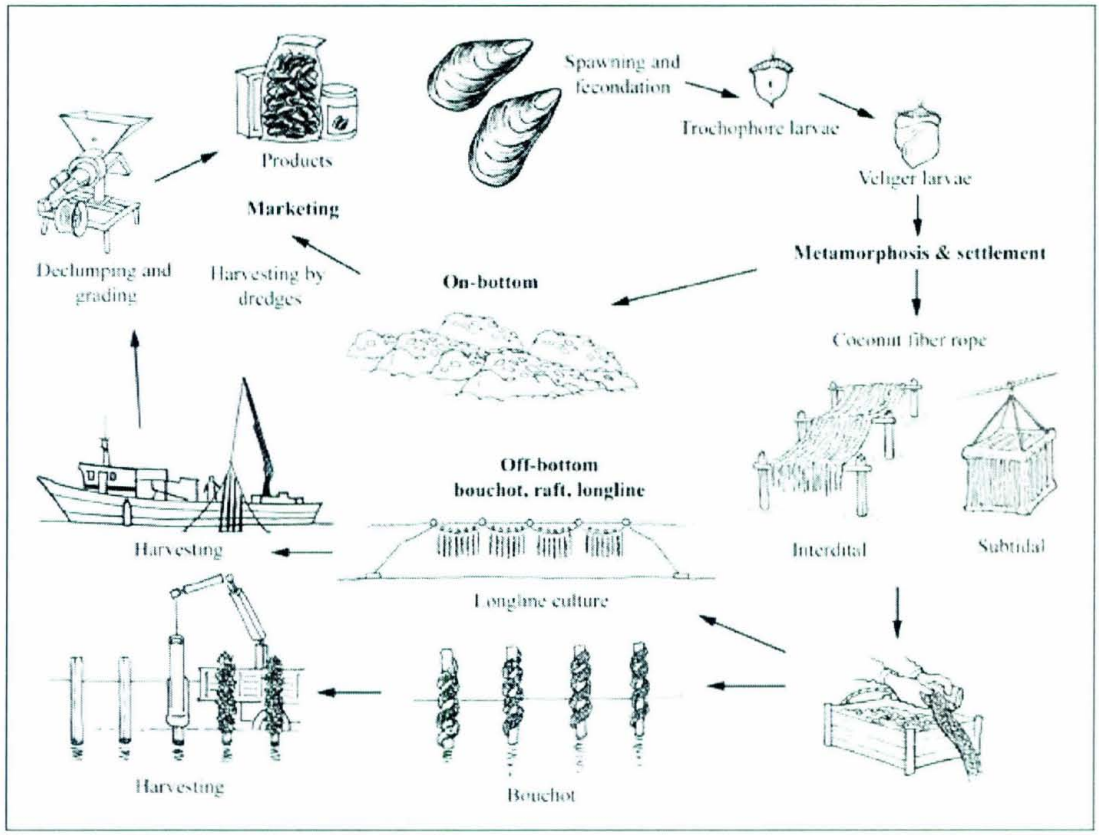


Figure 13: Production of blue mussel (Taken from FAO, 2011b).

Appendix B
Questionnaire

The purpose of this study is to examine current trends in both the capture fishery and aquaculture industry to determine how changes in these industries have, or may affect the future socio-economic environment of many coastal communities in Newfoundland and Labrador.

Participation is totally voluntary and if you feel that you need more space to fully answer a question, please feel free to continue on a new page. **As this study consists of only a small group of individuals, any and all of your comments will be held strictly confidential, in a secure location, and your identification will be kept anonymous**. In the future, this study may form the basis for a larger study so it is essentially a preliminary survey of trends in our coastal communities.

If you have any comments or concerns, you can contact Perry Rumbolt at (709) 722-9052 or by email at perryrumbolt@hotmail.com or you can contact Professor Couturier at (709) 778-0609 or by email at cyr@mi.mun.ca. Once you have completed the questionnaire, you can email your responses to me at the email address above, or I can call you to complete the questionnaire by telephone.

Thanks you for participating in my study, it is greatly appreciated.

Perry Rumbolt
Candidate Masters of Marine Studies – Fisheries Resource Management
Memorial University of Newfoundland

1) How important was/is the commercial fishing industry to the local area?

2) With the down turn in the fishing industry, how has the local area been affected?

3) When did the aquaculture industry start in your area?

4) What species are being produced?

5) In what way has aquaculture affected the socio-economic environment of your community with respect to:

- Employment?

- Community growth?

- Availability of goods and services?

- Level of construction?

- Overall sense of well being within the community?

6) How do you expect the growth in the local aquaculture industry to affect the socio-economic future of your community?

7) Do you have any other comments or questions regarding the purpose or any aspect of this study?

Thank-You